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THE NATIONAL SHIPBUILDING RESEARCH PROGRAM

**Establish Recommended
American Shipbuilding
Quality Standards - Final Report**

U.S. DEPARTMENT OF THE NAVY
CARDEROCK DIVISION,
NAVAL SURFACE WARFARE CENTER

in cooperation with
Newport News Shipbuilding

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National Shipbuilding Research Project
6-97-1

AMERICAN SHIPBUILDING QUALITY STANDARDS

FINAL REPORT

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BACKGROUND

Quality standards at competitive commercial shipbuilders in Europe and the Far East play a significant role in establishing customer expectations of ship construction quality and controlling cost. Most commercial ship buyers expect ship construction to meet standards as set forth in the *Japanese Shipbuilding Quality Standards* (JSQS) or equivalent. The JSQS sets dimensional tolerances and quality limits on key attributes for hull fabrication and construction, and outfitting manufacture and installation. The U.S. shipbuilding industry does not currently have a shipbuilding quality standard comparable to the JSQS. Consequently, the U.S. builder either develops a standard for a specific contract at the time of negotiation, or agrees to comply with the JSQS as directed by the potential buyer. The U.S. shipbuilding industry concurs that it would benefit from having an *American Shipbuilding Quality Standard* (ASQS).

PROJECT OBJECTIVE

Develop a *Recommended American Shipbuilding Quality Standard* for hull, outfitting and coatings. The standards would be comparable to current international standards of shipbuilding quality, would be a consensus, and would have acceptance of the U.S. shipbuilding industry.

TECHNICAL APPROACH

The Recommended American Shipbuilding Quality Standards would consist of three volumes: Hull, Outfitting, and Coatings.

The Hull volume would be patterned after the JSQS Hull Part dated 1991. It would consist of general steel fabrication, alignment, finishing, and defect acceptability guidance that describes workmanship standards used in the world market and expected by ship owners. This volume would reflect all past pertinent work conducted by NSRP, panels SP-4 and SP-6 in particular, and the Ship Structures Committee.

The Outfitting volume would be patterned after the JSQS Outfitting Part dated 1994 and would contain general dimensional and fit-up tolerances, ranges, and limitations that describe acceptable worldwide practice and U.S. shipyard capabilities in these areas.

The Coatings volume would describe general coating practice and provide recommended guidelines for inspection, measurement, and defect acceptance. Development of this volume would review work done by NSRP Panel SP-3, the American Bureau of Shipping, the Steel Structures Painting Panel, and National Association of Corrosion Engineers.

Specifically, the project would:

1. Obtain copies of the JSQS and Shipbuilding Paint Application and Inspection Standards.
2. Transfer the obtained documents into electronic (computer-based) format.
3. Identify current U.S. quality standards covering items similar to those covered by the JSQS.
4. Using JSQS as an index, list quality criteria from national standards currently used to guide U.S. shipbuilders.
5. Develop a draft guideline containing a summary of all quality guidelines as compared to JSQS.
6. Solicit U.S. shipyards for participation in this project at their own cost.

7. Task selected U.S. shipyards to review the draft guidelines. The shipyards would: a) evaluate the guidelines against current practices, b) recommend changes to the draft guidelines with supporting rationale, c) identify additional areas that could be covered by the guidelines, and d) identify areas where future NSRP projects could be used to bring U.S. shipbuilding quality up to JSQS standards.

ACCOMPLISHMENT

Task 1.0: Determine International Shipbuilding Standards

The first phase of the project involved searching for existing shipbuilding quality standards. The project team researched libraries, the Internet, and contacted domestic and international shipbuilders. Queries were also made to classification societies and other regulatory bodies.

Three standards from international commercial shipbuilders were obtained during a trip to the Far East for an unrelated project. Two more international standards were obtained through working affiliations between Newport News Shipbuilding and foreign shipyards. About half of the other European shipyards contacted by phone, email, and letter responded, but no additional standards were obtained from these contacts.

Twenty-one standards specific to Structure and Hull, one specific to Outfitting only, five specific to Coatings, and five combining more than one area were obtained; in all, a total of thirty-two source documents. In addition, five reference documents were found that provided information useful to establishing shipbuilding standards. A list of the standards and reference documents are in Appendix A.

Task 2.0: Determine American Shipbuilding Quality Standards

The Japanese Shipbuilding Quality Standard, with consideration to other existing standards, was used as the baseline for establishing the ASQS. The JSQS along with standards obtained from international shipbuilders were compiled in side-by-side matrix format to provide a convenient means for comparing standards by common attribute. No proprietary information was included in the ASQS or associated reporting.

The project team analyzed how the various shipbuilders treated each ship construction attribute, and derived the “Recommended American Shipbuilding Quality Standard” for each attribute. The analysis also considered whether or not to include a specific attribute in the ASQS. The matrix of “Recommended American Shipbuilding Quality Standards” was distributed to selected U.S. shipbuilders for review and comment and to gain concurrence and endorsement of the ASQS from the U.S. shipbuilding industry at large.

The final ASQS will be submitted to ASTM for inclusion in the ASTM library of standards.

The Recommended American Shipbuilding Quality Standard matrix was compiled for distribution in CADAM drawing format, a computer aided design software tool. The CADAM drawing format was selected over other documentation alternatives based on ease of compilation, readability, ease of distribution, and compatibility with U.S. shipbuilder end user capabilities. The alternative data compilation formats considered were Microsoft Excel (spreadsheet), Microsoft Access (database), and Microsoft Word (document). The pros and cons of each format were determined to be as follows:

Table 1 Comparison of Data Compilation Formats

Format	Pros	Cons	Comment
Excel	<ul style="list-style-type: none">▪ Spreadsheet provides for easy organization of data in side by side format.▪ Data can be sorted after all entries are made.▪ Spreadsheet cells can accommodate text, sketches and graphics.	<ul style="list-style-type: none">▪ Comparison of five standards makes width of spreadsheet unwieldy for visual comparison of data.▪ End user must be skilled to sort complex, multi-layered data.▪ Not all U.S. shipyard reviewers have ready access to a personal computer and latest version of Excel.▪ ASTM will not use this electronic format so it adds no value to the final product.▪ Hard copy output is difficult; requires printing on 8 ½ x 11 inch paper cut and taped into large document. Conversion to larger size paper is technically difficult.	Although Excel provides sorting capability, the nature of the multi-tiered (nested) data makes sorting in Excel not practical. At least one U.S. shipbuilder was expected to lack any capability whatsoever with Excel. This would require a “special” document of distribution to this one end user, adding time and cost to the project.
Access	<ul style="list-style-type: none">▪ Can display contents in several formats (e.g. table, report, spreadsheet, form record).▪ Data easily sorted and extracted for use.▪ Can accommodate text, sketches, and graphics.	<ul style="list-style-type: none">▪ Input of data is complex and source of potential error due to multi-tiered nature of data.▪ Data creators and end users do not possess the advanced skills needed to extract and view the data.▪ Hard copy output is difficult; requires printing on 8 ½ x 11-inch paper cut and taped into large document. Conversion to large size paper is technically difficult.▪ ASTM will not use this electronic format so it adds no value to the final product.	See above.

Table 1 Comparison of Data Compilation Formats (cont'd)

Word	<ul style="list-style-type: none">▪ Table feature displays data in format similar to existing data.▪ Tables are easily formatted for multi-tiered data.▪ Data creators and end users have requisite skills to extract and view the data.▪ Word is readily available to most end users	<ul style="list-style-type: none">▪ Large amount of data does not readily fit on standard print size paper.▪ Also, size of document and table required is unwieldy and causes software application to "act up" frequently.▪ Hard copy output is difficult and viewing in electronic format is impractical.▪ Not all reviewers have ready access to a personal computer and the latest version of Word.	
CADAM	<ul style="list-style-type: none">▪ Easiest to configure for data input and display.▪ Easily extracted and printed on standard size drawing paper for distribution and visual comparison of side by side standards.▪ Does not require any special skill, software, personal computer or other hardware for end users to review and comment.▪ Enables conversion from large matrix working document containing all existing standards to the final ASQS document.	<ul style="list-style-type: none">▪ Data cannot be readily sorted after input.	Data maintenance subsequent to compilation is outside the scope of this project, therefore, electronic format and sort capabilities are not needed. Final data will be forwarded to ASTM in hard copy format on standard 8 ½ x 11-inch format similar to the JSQS document.

Task 3.0: Develop Draft American Shipbuilding Quality Standards

Copies of specific sections of the JSQS and the other international shipbuilding quality standards were assigned to engineers with expertise in each area, (e.g., piping, steel fabrication, coatings). The assigned engineer annotated each section of the various standards to provide instructions to the CADAM draftspersons.

Using CADAM, the project team drew the matrix of existing standards on standard "C" size drawing paper for distribution to U.S. shipbuilders. The format was arranged with each attribute from the JSQS (sketch and description) in the first column on the left side. The second column was used for the Recommended American Shipbuilding Quality Standard "pass/fail" criteria. The first and second columns, when combined, form an 8 ½ x 11-inch booklet format similar to those of the two JSQS volumes. The third column contained the original "pass/fail" criteria for the attribute from the JSQS. Beginning with the fourth column and continuing to the right in adjacent columns, each additional existing international standard was compiled for each corresponding attribute.

The Recommended ASQS draft was organized as shown in Figure 1.

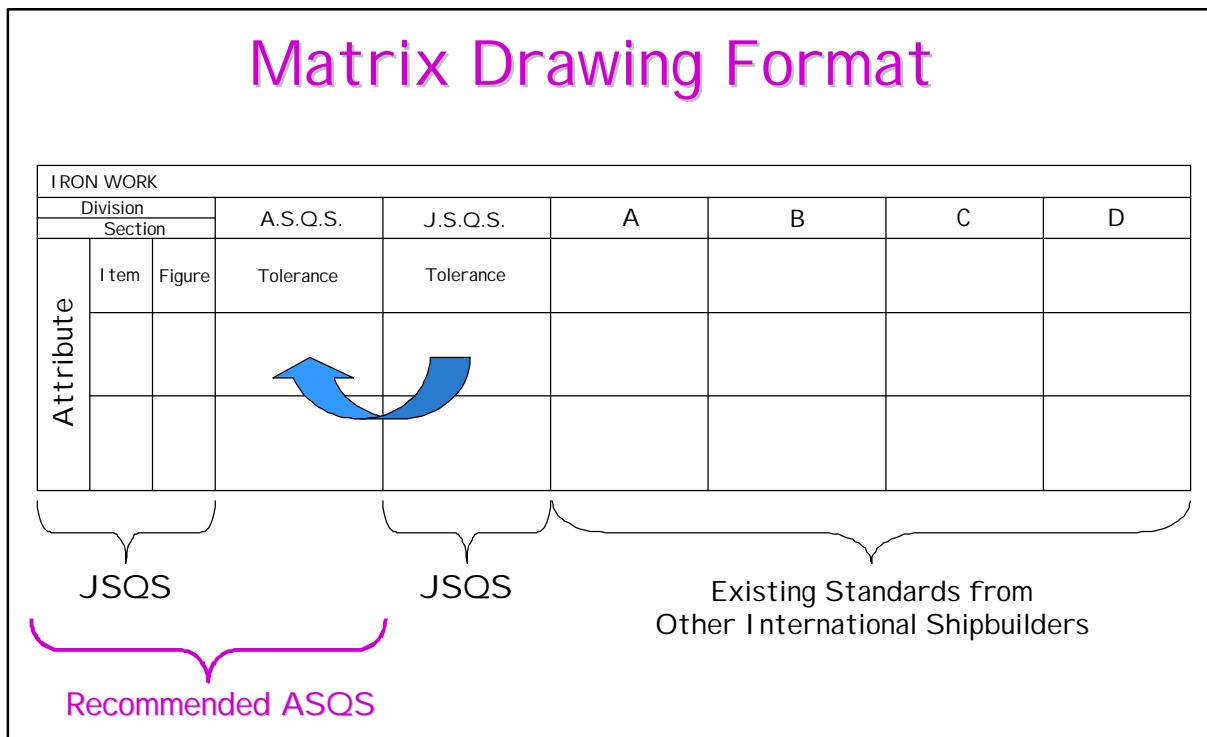


Figure 1

After the completed drawing with all attributes was distributed, reviewed and an acceptable ASQS was agreed upon by U.S. shipbuilders, columns one and two were cut from the matrix to become the ASQS. This was printed as an 8 ½ x 11-inch booklet as the final project deliverable and forwarded to NSRP.

The ASQS is organized into three volumes corresponding to three technical areas of ship construction: Hull, Outfitting, and Coatings. The three ASQS volumes are Attachments 1, 2 and 3 respectively. The content of each volume corresponds closely to the content of the JSQS with the exception of the Coatings volume. The JSQS did not address Coatings specifically. NNS project personnel compiled the Coatings volume using information from a wide variety of resource documents and company expertise. It was the intent of this project that the ASQS meet, but not exceed the JSQS level of quality. The ASQS does not contain nor duplicate standards that exist in whole, or in part, in any other U.S. standard. The ASQS is limited to dimensional tolerances, fit and finish inspection pass/fail criteria. It does not include quality "processes" or "philosophies." The ASQS applies to the following general attributes:

- Ship Structure such as:
 - ◆ Panels
 - ◆ Hull blocks
 - ◆ Shapes and plates
 - ◆ Fabricated assemblies

- ◆ Finished fittings and castings such as:
 - Bull Nose
 - Chocks and bitts
 - Anchor
 - Hull penetrations and shaft housings
- ◆ Joints between any of the above list
- Hull Outfitting such as:
 - ◆ Pipe stock
 - ◆ Pipe assemblies
 - ◆ Pipe and electrical hangers
 - ◆ Ventilation piping, ducting, and fittings
- Ship protective and decorative coatings to include:
 - ◆ Surface maintenance and preparations prior to coating application
 - ◆ Application parameters (temperature, time, atmospheric conditions, and cure time)
 - ◆ Final appearance and film thickness

The ASQS does not deal with functional, engineering or design issues relating to ships or ship systems.

The JSQS was used as a baseline. The project was based on the assumption that the JSQS would be adopted for the ASQS unless there was sufficient opposing rationale. Shipbuilders, first at Newport News Shipbuilding, then at other U.S. yards, were asked to review the JSQS criteria for each attribute and either accept it for the ASQS, or provide an alternative criteria with supporting rationale. Standards from four other international shipbuilders were placed in adjacent columns. This was done to allow the shipbuilders to see a full comparison of what other shipyards were using and how they compared to the JSQS. The other shipbuilders did not address all of the attributes contained in the JSQS. In these instances, "not addressed" was entered in the corresponding field.

The draft ASQS was completed the first week of March 1999. It consisted of three volumes: Hull, Outfitting, and Coatings. Copies of the three volumes were hand-delivered to representatives of four major U.S. shipbuilders (other than Newport News Shipbuilding) during the Maritech ASE "Shipyard Production Process Technologies" Panel meeting held March 10-11, 1999, in Biloxi, Mississippi. Each shipbuilder representative accepted a copy of the Standard and committed their shipyard to review and return the draft volumes to the project leader by April 16, 1999.

None of the four shipbuilders actually reviewed the draft ASQS as intended, primarily due to lack of funding. In the absence of comments on the draft, the project leader published and submitted the Recommended ASQS to NSRP as compiled and reviewed by Newport News Shipbuilding without additional alteration.

Task 4.0: Publish Recommended American Shipbuilding Quality Standards

Columns one and two were extracted from the matrix to form the three 8-1/2 x 11" booklets. They are Attachments 1, 2, and 3 to this report.

Task 5.0: NSRP Project Completion Report

The Project Completion Report containing the ASQS was forwarded to NSRP on May 28, 1999.

Project Final Deliverables

1. Recommended American Shipbuilding Quality Standards (Task 3.2)
2. Project Final Report (Task 5.1)
3. Final Quarterly Progress Report

National Shipbuilding Research Project

6-97-1

APPENDIX A

List of Standards In Hand

List of Standards In Hand

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Structural and Hull Outfitting

Title and Date	Issuing Agency	Received From
SHIPBUILDING AND REPAIR QUALITY STANDARD, Recommendation No. 47 (1996)	IACS (International Organization of Classification Societies)	Robert Letourneau (NNS)
SHIPBUILDING AND REPAIR QUALITY STANDARD FOR HULL STRUCTURES DURING CONSTRUCTION, July 1998	ABS (American Bureau of Shipping)	
SHIP PLATE DEFORMATION CRITERIA (Comparison of Japanese and German Practices)	SSC (Ship Structures Committee) Report 364 (excerpt)	SSC Report CD Set
B.I.W. INSPECTION GUIDELINES (before 1978)	Bath Iron Works (SSC Report 273)	Appendix 9.2.1.1, Issued 1978
RO/RO DIMENSIONAL CONTROL GUIDELINES (before 1978)	Bath Iron Works (SSC Report 273)	Appendix 9.2.1.1, Issued 1978
MANUFACTURING STANDARD PROCESS NO. 909-002 (before 1978)	Ingalls Shipbuilding (SSC Report 273)	Appendix 9.2.2, Issued 1978
SPECIAL TOLERANCES FOR DRILL RIG (before 1978)	Levingston Shipbuilding (SSC Report 273)	Appendix 9.2.3, Issued 1978
DIMENSIONAL TOLERANCES FOR LNG TANKERS (before 1978)	Newport News Shipbuilding (SSC Report 273)	Appendix 9.2.4, Issued 1978
STRUCTURAL TOLERANCES-Quality Control Instruction – Fairness (before 1978)	SEATRAIN SHIPBUILDING (SSC Report 273)	Appendix 9.2.5, Issued 1978
SHIPBUILDING PRODUCTION STANDARD (HULL DIVISION) 1976	SUN SHIPBUILDING & DRY DOCK (SSC Report 273)	Appendix 9.2.6, Issued 1978
UNFAIRNESS TOLERANCES, NAVSHIPS 0900-000-1001, June 1969	U.S. Navy (SSC Report 273)	Appendix 9.2.7, Issued 1978
Weld Specifications, date unknown	Excerpt from SSC Report 323	SSC Report CD set
Guide for Ship Structural Inspection, 1985	SSC Report 332	SSC Report CD set
Standard Guide for Steel Hull Construction Tolerances [metric] ASTM F 1053/F 1053M-94	ASTM (American Society for Testing and Materials)	Lee Anderson, NNS Steve Buttice, NNS
Japanese Shipbuilding Quality Standard (Hull Part) 1995	Research Committee on Steel Shipbuilding, Society of Naval Architects of Japan	Lee Anderson, NNS
JAPAN OFFSHORE STRUCTURES QUALITY STANDARD (J.O.Q.S.) 1986	Research Committee on Steel Shipbuilding, Society of Naval Architects of Japan	Lee Anderson, NNS

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Structural and Hull Outfitting (cont'd)

Quality Assurance and Quality Control Program (undated) (proprietary)	Sumitomo Heavy Industries	Lee Anderson, NNS
Production Standard of the German Shipbuilding Industry, Nov. 1974	Verband der Deutschen Schiffbauinsdustrie, e. V. (SSC Report 273)	Appendix 9.2.3, Issued 1978
Accuracy in Hull Construction, VIS 530, 1976	Swedish Shipbuilding Standards Center (SSC Report 273)	Appendix 9.3.3, Issued 1978
Alignment and Finishing, Background Document 8-3, Japanese Shipbuilding Quality Standards, 1975	SSC Report 273	Appendix 9.3.4, Issued 1978
Ship Plate Deformation Criteria	Excerpt from SSC Report 364	SSC Report CD set

Outfitting

Title and Date	Issuing Agency	Received From
Japanese Shipbuilding Quality Standard Outfitting Part, 1994	No. 2 Subcommittee of Research Committee on Steel Shipbuilding, Society of Naval Architects of Japan	Lee Anderson, NNS

Coatings

Title and Date	Issuing Agency	Received From
Guidelines for Corrosion Protection of Ships, No. 94-P005, April 1994	Det Norske Veritas Classification AS	Alan Titcomb, NNS
CORROSION CONTROL OF INTER-HULL SPACES, January 1996	SSC Report 390	SSC Report CD set
STANDARD COATING PRACTICE AND PAINTING PLAN, DOUBLE EAGLE PRODUCT CARRIER, 12/94	Newport News Shipbuilding	
TANK COATING SPECIFICATIONS FOR PRODUCT CARRIERS, April 1982	The Shipbuilder's Association of Japan	Alan Titcomb, NNS
Guidance for Corrosion Protection System of Hull Structures – For Water Ballast Tanks and Cargo Oil Tanks, 1994	Nippon Kaiju Kyokai Class NK	Alan Titcomb, NNS

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Combined

Title and Date	Issuing Agency	Received From
NEWPORT NEWS SHIPBUILDING COMMERCIAL SHIP INSPECTION STANDARD AND SHIPBUILDING PROCESSES, 10/4/95	Newport News Shipbuilding	Lee Anderson, NNS
SAMSUNG SHIPBUILDING QUALITY STANDARD, R5, 10/92	SAMSUNG Quality Control Department, Koje Shipyard	Lee Anderson, NNS
CSBC SPAIS SHIPBUILDING PROCESS AND INSPECTION STANDARD, 10/79	China Shipbuilding Corporation, Kaohsiung Shipyard Committee of Standards	Lee Anderson, NNS
HSQS, HYUNDAI SHIPBUILDING QUALITY STANDARD, 1995	Hyundai Heavy Industries Co. LTD., Shipbuilding Division, Doc. No. 2-C630-2-5501	Lee Anderson, NNS
IHI SPAIS, THE SHIPBUILDING PROCESS AND INSPECTION STANDARD, 1992 (Proprietary)	Ishikawajima-Harima Heavy Industries Co., LTD.	Lee Anderson, NNS

OTHER REFERENCES

Title and Date	Issuing Agency	Received From
Corrosion Protection of Ships – How can the Level of Corrosion be Reduced?, 1994	Det Norske Veritas, by Kjell Olaisen	Alan Titcomb, NNS
ABS and Coatings, March 1996	Corrosion 96 paper by Sudheer Chand, Chief Engineer, Technology Development, ABS Houston	Alan Titcomb, NNS
List: ABS Requirements Concerning Coatings and Corrosion Protection, undated	Unknown	Alan Titcomb
Brochure: Ballast Tank Integrity and the New IMO Coating Rule, undated	Jan Aubert, Jotun Marine Coatings, Sandefjord, Jotun Valspar Marine Coatings	Alan Titcomb, NNS
SURVEY OF STRUCTURAL TOLERANCES IN THE UNITED STATES COMMERCIAL SHIPBUILDING INDUSTRY, 1978, paper SSC Report 273	U.S. Ship Structure Committee	Lee Anderson, NNS

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